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DESCRIPTION

ALUMINUM-MADE HEAT EXCHANGER

Technical field

The present invention relates to an aluminum-made heat exchanger manufactured in such a manner that an aluminum strip-shaped material having a brazing metal and a sacrificial anode material on a core metal is bent in the width direction thereof to form a flat tube; many flat tubes are disposed parallel to each other to structure a core of the heat exchanger, and then subjected to a brazing in a furnace using a brazing flux to integrally fix the core of the heat exchanger.

Background Art

There is known an aluminum-made heat exchanger manufactured by bending a strip-shaped material coated with a brazing metal on the outer surface, and the seam thereof is integrally joined with a brazing metal.

Also, there is known a flat tube formed into a B-like shape in section. The flat tubes, which are coated with a brazing metal on the outer surface as described above, are disposed parallel to each other at same intervals; and corrugated fins are disposed between the flat tubes; and both ends of the flat tubes are inserted into tube insertion holes in the tube plates. The surface and the like of the brazing metal is previously applied with flux and is subjected to a

brazing in a furnace filled with atmosphere of inert gas; thus a heat exchanger is completed.

Further, on the inner surface of the flat tube, a sacrificial anode material is coated to prevent the inner surface side of the tube from corroding.

Furthermore, in order to increase the strength of the tube, in some cases, a sacrificial anode material, which includes Mg of 1% or more, is used. After the brazing, the Mg combines with Si component included in the base material and an Mg_2Si layer is formed on the base material; thereby the strength of the tube is increased.

However, the following fact was found. That is, in the case where a sacrificial anode material, which includes Mg 1% or more is used, when a brazing is carried out between the brazing metal at the outer surface side and the sacrificial anode material at the inner surface side being interposed by a flux, the Mg within the sacrificial anode material reacts with the flux and the brazing performance is reduced. That is, there may be a case such that a leakage occurs at a joined portion on the flat tube.

Therefore, an object of the present invention is to provide an aluminum-made heat exchanger, which is capable of being brazed satisfactorily on the joined portion thereof while maintaining the strength of the

flat tube.

Disclosure of the Invention

An aspect of the present invention, disclosed in claim 1, is an aluminum-made heat exchanger, having:

a flat tube (5) formed by, using an aluminum strip-shaped material of which core metal (1) is coated with a brazing metal (2) on the outer surface thereof and is coated with a sacrificial anode material (3) on the inner surface thereof, bending the strip-shaped material in the width direction,

many flat tubes (5) are disposed parallel to each other to form a core of the heat exchanger, and each of these parts are fixed integrally by means of brazing,

wherein the brazing metal (2) is of an Al-Si alloy, the core metal (1) is of an Al-Si alloy including Si of 0.4 to 1.2% by weight, the sacrificial anode material (3) is of an Al-Mg-Zn alloy including Mg of 0.3 to 0.75% by weight, the aluminum-made heat exchanger is structured by being subjected to a brazing in a furnace using a flux for brazing to join the parts being interposed by the brazing metal (2).

Another aspect of the present invention, disclosed in claim 2, is the aluminum-made heat exchanger according to claim 1, wherein the brazing metal (2) of an aluminum alloy including Si of 7.5 to 12% by weight, the core metal (1) is equivalent to A3003

of A. A. Standard (0.15% by weight of Cu, 1.2% by weight of Mn and balance of Al: the same is applied in the following) aluminum material added with Si of 0.4 to 1.2% by weight, the sacrificial anode material (3) is equivalent to A7072 of A. A. Standard (0.1% by weight of Zn and balance is Al: the same is applied in the following) added with Mg of 0.3 to 0.75% by weight.

The aluminum-made heat exchanger according to the present invention has a structure as described above, and provides the following effects.

In the aluminum-made heat exchanger according to the present invention, the flat tube 5 is joined being interposed by the brazing metal 2 coated at the outer surface side thereof using a flux by means of brazing in a furnace. The core metal 1 is of an Al-Si alloy; and the sacrificial anode material 3 coated on the inner surface of the tube is an Al-Mg-Zn alloy including Mg of 0.3 to 0.75% by weight.

As described above, by adding Mg of 0.3 to 0.75% by weight to the sacrificial anode material 3, the Mg and the Si of the core metal 1 combine with each other after the brazing to increase the strength of the base material. Moreover, since the Mg is controlled to be 0.75% or less by weight, the brazing performance with the brazing metal 2 is satisfactorily ensured; and accordingly, an aluminum-made heat exchanger with a

high air and liquid tightness can be provided.

Brief Description of the Drawings

Fig. 1 shows an enlarged view of a flat tube for an aluminum-made heat exchanger according to the present invention, illustrating a relevant portion before brazing.

Fig. 2 shows a plane view of the heat exchanger, illustrating the assembly state thereof.

Fig. 3 shows a schematic sectional view taken along a line III-III in Fig. 2.

Fig. 4 shows a front view illustrating a relevant portion of the aluminum-made heat exchanger according to the present invention.

Fig. 5 illustrates the state of applied flux in a partition part 4 in the flat tube of the heat exchanger.

Best Mode for Carrying Out the Invention

An embodiment of the present invention is described below referring to the drawings.

Fig. 1 shows an enlarged view of a flat tube for an heat exchanger according to the present invention, illustrating a relevant portion before brazing; Fig. 2 shows a plane view of the heat exchanger, illustrating the assembly state thereof; Fig. 3 shows a schematic sectional view taken along a line III-III in Fig. 2; and Fig. 4 shows a front view illustrating a relevant

portion of the heat exchanger.

As shown in Fig. 4, the heat exchanger has many flat tubes 5 disposed parallel to each other at certain intervals and corrugated fins 10 disposed between the flat tubes 5, and both ends of the respective flat tubes 5 are inserted into tube insertion holes in tube plates 6; thus a core is assembled.

The flat tube 5 is formed, for example, by bending a strip-shaped material into a B-like shape in section as shown in Fig. 1 and Fig. 2. The flat tube according to the present invention includes such a tube that has no partition part at the center thereof.

The strip-shaped material is coated with a brazing metal 2 at the outer surface side of the core metal 1, and the inner surface side thereof is coated with a sacrificial anode material 3.

The core metal 1 is formed of, for example, a plate material in which aluminum material of A3003 (A. A. Standard of US Aluminum Association: the same is applied in the following) added with Si of 0.4 to 1.2% by weight; and the brazing metal 2 is an aluminum alloy including Si of 7.5 to 12% by weight.

Also, the sacrificial anode material 3 is an aluminum alloy equivalent to A7072 (A. A. Standard) added with Mg of 0.3 to 0.75% by weight. These plate materials are joined with pressure to form a 3-layered

brazing sheet.

The strip-shaped material as described above is bent continuously in a manner of, for example, roll forming; a partition part 4 is formed by turning up at the central portion thereof in the width direction; both edges of the strip-shaped material are folded back toward the inner surface side to form turned-back ends 7; and the entire thereof is bent into a flat tube shape so that the brazing metal 2 of the turned-back ends 7 abut on the top portion of the partition part 4.

On the top portion of the partition part 4, a flux 8 is applied beforehand. As for the applying method of the flux, for example, as shown in Fig. 5, in a state that the strip-shaped material has a gate-like shape in section in the process of forming the tube, the top portion of the partition part 4 at the central portion of the inner surface is applied with the flux 8 from a container 12 via a flux applying wheel 13. The flux-applying wheel 13 is driven to rotate, and in a state that the flux 8 is applied in a ring-like groove 14 thereof, and the flux 8 is transferred to the central portion of the partition part 4.

Further, the flux 8 is supplied afterward to the butting surface of both turned-back ends 7 of the strip-shaped material and is applied to the outer surface side also of the flat tube 5.

As for the flux 8, any known flux from chlorides or fluorides may be used. For example, KF-AlF_3 (and Nocolok (product name) is available. As for the adhesive, an acrylic resin binder is used. As for the thinner, machine oil, oil or the like may be used.

Samples, which have material components within the range according to the present invention, and samples, which have material components out of the range of the present invention, were prepared, and experiments were made and the brazing performance and the strength were compared among the samples.

In the sacrificial anode material, the amount of the Mg included therein were different from each other as 0.2%, 0.3%, 0.6%, 0.75%, 0.8%, 1.0% as shown in table 1, the other components included in the sacrificial anode material is the identical to those of the A7072; i.e., Zn is 1.0%, and the balance is Al.

The core metal is of the materials equivalent to those of A3003 added with Si of 1.0%; i.e., Cu is 0.15%; Si is 1%, Mn is 1.2% and the balance is Al.

Further, the brazing metal includes Si of 10%, and the balance is Al.

With respect to the contents of the Mg of sacrificial anode material as described above, the strength after brazing and the brazing performance were examined.

[Table 1]

	Sacrificial anode material (A7072 equivalent + Mg amount)	Core metal (A3003 equivalent + Si amount)	Brazing metal (Balance Al + Si amount)	Strength (Kg/mm^2)	Brazing performance	Judgment
1	0.2%	1%	10%	125	O	×
2	0.3%	1%	10%	140	O	O
3	0.6%	1%	10%	165	O	O
4	0.75%	1%	10%	170	O	O
5	0.8%	1%	10%	172	×	×
6	1.0%	1%	10%	175	×	×

As a result, when the amount of Mg included in the sacrificial anode material was 0.3%, the strength was 140 kg/mm^2 or more. When the amount of Mg was 0.2%, the strength was 125 kg/mm^2; it was smaller than a desired strength of 140 kg/mm^2.

When the amount of Mg was 0.8% and 1.0%, although a satisfactory strength was ensured, a problem resided in brazing performance. That is, the flux and Mg reacted with each other reducing the brazing performance. Therefore, the amount of Mg included in the sacrificial anode material that satisfies both of the strength and the brazing performance is 0.3 to 0.75% by weight; an Al-Mg-Zn alloy.

The core metal may include Si of approximately 0.4 to 1.2% by weight. In this case also, the same results as the above were obtained.